

## Bearing Device With A Sensor

### FIELD OF THE INVENTION

The present invention relates to a bearing device with a sensor such  
5 as, for example, a wheel support bearing assembly with a revolution sensor for  
use in an automotive vehicle and in any other field of application.

### BACKGROUND ART

Wheel support bearing assemblies used in automotive vehicles make  
use of a revolution sensor for detecting the number of revolutions of a vehicle  
10 wheel for the purpose of controlling an anti-lock brake device and any other  
purpose. The revolution sensor is made up of a magnetic encoder of a  
ring-shaped configuration fitted to an inner race, which serves as a rotatable  
raceway member, and a sensor fitted to an outer race, which serves as a  
stationary raceway member, for detecting the magnetic encoder in a non-contact  
15 fashion.

As a first example of configuration for fitting the sensor, the use of a  
sensor mounting member prepared by pressing a sheet metal has been suggested  
(See, for example, the Japanese Laid-open Patent Publication No. 6-308145.).  
This suggested sensor mounting member includes a cutout hole formed in an  
20 annular support that is mounted on and, hence, fitted to the outer race, a pair of  
slide groove forming portions defined on respective side edges of the cutout hole  
for engagement with side portions of the sensor, and a tongue provided in a lower  
edge of the cutout hole for urging a rear face of the sensor.

As a second example of configuration for fitting the sensor, the  
25 example is known, in which a retaining member of an arcuate configuration is  
molded integrally with an outer race mounting tube of an annular configuration  
mountable on the outer race to form a sensor holder and a sensor element is  
embedded in the retaining member provided in a portion of this sensor holder  
(See, for example, the Japanese Laid-open Patent Publication No. 2003-254985).

Although the above described first example of configuration, in which the sensor is inserted in between the slide groove forming portions and is then urged by the tongue has such an advantage as to enable it to be simply mounted, there is a possibility of accidental separation. Also, since the wheel support bearing assembly is placed under the environment tending to be exposed to the road surface, grits and sands are apt to ingress in between the sensor and the magnetic encoder, resulting in the possibility of breakage.

Also, the above described second example of configuration is such that since the retaining member of the sensor holder, in which the sensor element is embedded, and the outer race mounting tube are molded integrally with each other, the sensor holders of varying sizes must be manufactured for each size of the bearing devices with sensors, which vary in size depending on the type of automotive vehicles and the bearing capacity, resulting in increase of the cost.

#### DISCLOSURE OF THE INVENTION

An object of the present invention is to provide a bearing device with a sensor, in which the fitting of the sensor is assured and excellent in reliability, and which can be easily applied to bearing parts of different sizes and can be made at a low cost.

A bearing device with the sensor according to the present invention is a bearing device with a sensor, comprising a bearing part including an outer member having a raceway defined in an inner periphery thereof, an inner member having a raceway confronting the raceway in the outer member, and rolling elements interposed between those raceways, and a revolution sensor part including an encoder, fitted to one end of the inner member, and a sensor fitted to one end of the outer member in face-to-face relation with the encoder, wherein the sensor is fitted through the following sensor mounting member.

The sensor mounting member has a mounting tube part mountable on an outer diametric surface of the outer member and a side plate part axially positioned in contact with an end face of the outer member. The side plate part

of the sensor mounting member is provided with a recessed plate section, which has an inner surface side recessed, and an opposite plate part confronting a bottom surface portion of the recessed plate section, the sensor being fitted sandwiched between the bottom surface portion of the recessed plate section and the opposite plate part. The recessed plate section has a sectional shape along, for example a radial direction of a bearing part, which represents a shape of the figure "U".

According to this construction, since the sensor is fitted sandwiched between the bottom surface portion of the recessed plate section provided in the sensor mounting member and the opposite plate part, there is no possibility of the sensor being detached and the fitting can be assured and highly reliable. Since the sensor mounting member is mounted on the outer diametric surface of the outer member through the mounting tube part and is axially positioned in contact with the end face of the outer member through the side plate part, the positioning can be easily and accurately performed, rendering the positioning accuracy of the sensor relative to the encoder to be excellent. Although the sensor referred to above has the sensor element embedded in, for example, the sensor holder made of a resinous material, this sensor holder is manufactured separate from the sensor mounting member and is fitted to the sensor mounting member. For this reason, where fitting is made to the bearing part of a different size, it is sufficient for the sensor mounting member to be complied with the size of the bearing part and the sensor provided with the sensor holder can be used for the different size of the bearing part by the employment of the same element. Accordingly, the sensor unit comprised of the sensor and the sensor mounting member can be manufactured at a low cost.

The sensor mounting member may include inner and outer plates prepared from two sheet metals and overlapped one inside the other. In such case, the recessed plate section is provided in the outer plate and the opposite plate part is provided in the inner plate.

Where the sensor mounting member is made up of the inner and outer plates overlapped with each other, a work of sandwiching the sensor between the U-shaped recessed plate section and opposite plate part of the sensor mounting member can be simplified.

5           The recessed plate section and opposite plate part of the sensor mounting member may have respective sensor fitting openings for allowing the sensor to pass therethrough from outside to inside, in which the sensor has a protruding part, which protrudes towards a portion or whole of an perimeter of each of the sensor fitting openings, and the protruding part is sandwiched  
10   between the bottom surface portion of the recessed plate section and the opposite plate part.

Where the side plate part of the sensor mounting member is provided with the sensor fitting opening, the sensor can be opposite directly to the encoder without the intervention of the side plate part. Also, where the sensor fitting  
15   opening is provided in the recessed plate section, drawing of an electric wiring to the outside can be facilitated. When those sensor fitting openings are provided, it is possible to position the sensor relative to the radial and circumferential directions of the bearing part by allowing an outer periphery of the sensor to engage the sensor fitting openings.

20           In the present invention, an elastic element may be interposed between the bottom plate portion of the recessed plate section or the opposite plate part and the sensor.

When the elastic element is so interposed, the sensor can be stably retained by the sensor mounting member without being loosened and, also,  
25   without an excessive sandwiching force induced.

The elastic element may concurrently serve as a seal for sealing between the inner member and the sensor mounting member. By way of example, the elastic element is so constructed that an inner peripheral edge of the

elastic element can slidingly engage with an outer peripheral surface of the inner member.

In such case, the elastic element can be used concurrently for the stable fitting of the sensor and a sealing means and, without increasing the number of component parts, the sealability can be increased. Also, when the elastic element is used to seal a space between the inner member and the sensor mounting member, biting of foreign matters between the encoder and the sensor is prevented and, even when the bearing device with the sensor of the present invention is applied to a wheel support bearing assembly, biting of sand particles, which results from scattering of stones from the road surface, in between the encoder and the sensor can be prevented.

In the present invention, each of the encoder and the sensor may be either a magnetic type or an optical type. In the case of the magnetic type, the encoder is rendered to be a magnetic encoder formed with alternating magnetic poles deployed in a circumferential direction and the sensor may be a magnetic sensor utilizing, for example, a Hall element or a magnetoresistive element..

The bearing device with the sensor according to the present invention can be applied to any bearing device used in various field of application, for example, to a wheel support bearing assembly. In such case, the bearing part referred to previously may include the outer member having a plurality of raceways defined in the inner periphery thereof, the inner member having respective raceways confronting the raceways in the outer member, and a plurality of rows of rolling elements interposed between those opposite raceways, and be operable to rotatably support a vehicle wheel relative to an automotive vehicle body.

Since the wheel support bearing assembly is placed under the severe environment tending to be exposed to vibration and also to the road surface, from which it tends to be contaminated with grits and sands, advantages of the present invention that the fitting of the sensor is assured and excellent in reliability can

be exhibited effectively. Also, use to the wheel support bearing assemblies of varying size can be made easily and at a low cost.

#### BRIEF DESCRIPTION OF THE DRAWINGS

In any event, the present invention will become more clearly  
5 understood from the following description of preferred embodiments thereof,  
when taken in conjunction with the accompanying drawings. However, the  
embodiments and the drawings are given only for the purpose of illustration and  
explanation, and are not to be taken as limiting the scope of the present invention  
in any way whatsoever, which scope is to be determined by the appended claims.  
10 In the accompanying drawings, like reference numerals are used to denote like  
parts throughout the several views, and:

Fig. 1(A) is a longitudinal sectional view of a bearing device with a  
sensor according to a first preferred embodiment of the present invention, which  
is in the form of a wheel support bearing assembly;

15 Fig. 1(B) is a front elevational view thereof, showing a sensor  
mounting member and a sensor;

Fig. 2 is an enlarged fragmentary sectional view of Fig. 1(A);

Fig. 3(A) is a longitudinal sectional view of the bearing device with  
the sensor according to a second preferred embodiment of the present invention,  
20 which is in the form of a wheel support bearing assembly;

Fig. 3(B) is a front elevational view thereof, showing the sensor  
mounting member and the sensor; and

Fig. 4 is an enlarged fragmentary longitudinal sectional view of Fig.  
3(A).

#### 25 BEST MODE FOR CARRYING OUT THE INVENTION

The first embodiment of the present invention will be described with  
reference to Figs. 1 and 2. This embodiment is applied to a wheel support  
bearing assembly of a third generation type. This bearing device with a sensor

is such that a revolution sensor part 2 is fitted to a bearing part 1 and Fig. 1(A) illustrates a constant velocity joint 14 connected thereto.

The bearing part 1 includes an outer member 3 having an inner periphery formed with a plurality of raceways 5, an inner member 4 formed with  
5 raceways 6 confronting the respective raceways 5, and double rows of rolling elements 7 interposed between the raceways 5 in the outer member 3 and the raceways 6 in the inner member 4. The rolling elements 7 of each of the double rows are retained by a corresponding retainer 8. Opposite ends of a bearing space delimited between the outer member 3 and the inner member 4 are sealed  
10 by respective seals 9 and 10.

The outer member 3 is of one-piece construction including a flange 3a provided in an outer periphery thereof, which is fitted to, for example, a knuckle in a suspension device (not shown) of an automotive vehicle body.

The inner member 4 is made up of a hub axle 11, having a wheel  
15 mounting flange 11a on an outboard end thereof, and an inner race 12 mounted on an outer periphery of an inboard end of the hub axle 11, with the raceways 6 provided respectively in the hub axle 11 and the inner race 12. It is to be noted that the term "outboard" is intended to represent an outer side in a direction widthwise of the automotive vehicle body in a condition, in which the wheel support bearing assembly is mounted on the automotive vehicle, and a side  
20 representing an inner side is represented by the term "inboard".

The inner member 4 has a center bore 13 and a stem portion 15a of an outer race 15, which serves as one of joint members of a constant velocity joint 14, is inserted and splined thereto. A free end of the stem 15a has a male thread  
25 part and, by fastening a nut 16 threadingly engageable with this male thread part, the constant velocity joint outer race 15 is coupled with the inner member 4. At this time, when a stepped face 15b provided in the constant velocity joint outer race 15 is urged against an end face of the inner race 12 of the inner member 4, the inner race 12 is fixed to the hub axle 11.

As shown in Fig. 2 on an enlarged scale, the revolution sensor 2 includes an encoder 17, fitted to an end outer periphery of the inner member 4, and a sensor 18 fitted to an end of the outer member 3 in face-to-face relation with the encoder 17.

5           The encoder 17 is in the form of a magnetic encoder and is of a type, in which a multipolar magnet 17b is provided on a side plate part of an annular core metal 17a of a L-sectioned configuration. The encoder 17 is fitted to the inner member 4 by causing a cylindrical part of the core metal 17a to be press-fitted on the outer periphery of the inner member 4. The multipolar  
10 magnet 17b is a member formed with a plurality of alternating magnetic poles N and S deployed in a circumferential direction thereof and may be in the form of a rubber magnet, plastic magnet or sintered magnet.

In the illustrated embodiment, the encoder 17 concurrently serves as a component part of the seal 10 on the inboard side and exhibits a function as a  
15 slinger. This seal 10 is made up of the core metal 17a of the encoder 17 and a sealing member 10a mounted inside an inner bore of the outer member 3. The sealing member 10a is represented by an elastic element such as, for example, rubber provided on an annular core metal, which elastic element is provided with a plurality of lip parts 10c having their free ends slidably engaged with the side  
20 plate part and a cylindrical part of the encoder 17.

The sensor 18 is a magnetic sensor for detecting a magnetic field of the encoder 17 and is fitted to the outer member 3 through a sensor mounting member 22. The sensor 18 is of a type, in which a sensor element 19 such as, for example, a Hall element or a magnetoresistive element is embedded in a  
25 sensor holder 20 made of, for example, a resinous material. In the sensor 18, the magnetic detecting element 19 is provided in, for example, two in number in a fashion spaced in a circumferential direction relative to an arrangement of the magnetic poles of the encoder 17, so that two pulse outputs, offset 90° in electric phase from each other, can be obtained. For this reason, a body part 20a of the



sensor holder 20 of the sensor 18 is rendered to represent an arcuate shape, in a front elevational shape thereof, that is concentric with a bearing center. The sensor holder 20 has a protruding part 20b extending from a portion thereof adjacent a free end of the body part 20a in a radially outward direction and is provided with a cord cover part 20c extending in a direction away from a detecting surface with its diameter progressively decreasing. A cord 21 extends from a free end of the cord cover part 20c. The protruding part 20b is rendered to protrude from the entirety of the body part 20a in a circumferential width of the bearing of the body part 20a in a radially outward direction.

10           The sensor mounting member 22 has a mounting tube part 22a, which is adapted to be mounted on an outside surface of the outer member 3, and a side plate part 22b axially positioned in contact with an end face of the outer member 3. This side plate part 22b is provided with a recessed plate section 25, having its inner surface side recessed to represent a cup-like configuration, and an opposite plate part 26 held in face-to-face relation with a bottom surface part 25a of this recessed plate section 25, and the sensor 18 is fitted sandwiched between the bottom surface part 25a of the recessed plate section 25 and the opposite plate part 26. The recessed plate section 25 has a sectional shape along a radial direction thereof, which represents a U-sectioned configuration. More specifically, the recessed plate section 25 has its front elevational shape, which represents an arcuate shape extending in a direction circumferentially of the sensor mounting member 22 as shown in Fig. 1(B) and opposite ends adjacent an outer and inner peripheries of the arcuate shape are continued to each other through sides of the arcuate shape.

25           The sensor mounting member 22 includes two metallic plates, i.e., an inner plate 23 and an outer plate 24, which are overlapped one inside the other, and the recessed plate section 25 referred to previously is provided in the outer plate 24 while a part of the inner plate 23 defines the opposite plate part 26 referred to previously. In the instance as shown, the opposite plate part 26 is

constituted by a part opposite to the bottom surface part 25a of the recessed plate section 25 of the outer plate 24 in a side plate part of the inner plate 23. Each of the inner plate 23 and the outer plate 24 is prepared from a sheet metal by the use of any press work.

5                   Fitting of the sensor mounting member 22 to the outer member 3 is carried out by, after the mounting tube part 22a has been press-fitted onto the outside surface of the outer member 3, providing a crimped part 27 at a plurality of circumferential locations of the mounting tube part 22a. The crimped part 27 is in the form of an embossed projection and is provided for engagement with an  
10                   engagement groove 28 formed in the outside surface of the outer member 3 at a location adjacent one end thereof. It is to be noted that the mounting tube part 22a may be fitted to the outer member 3 solely by means of a press-fitting.

                  The recessed plate section 25 and opposite plate part 26 of the sensor mounting member 22 have respective sensor fitting openings 29 and 30 defined  
15                   therein for allowing the sensor 18 to extend therethrough from outside to inside, and those sensor fitting openings 29 and 30 are of a shape sufficient to fit around an outer periphery of the sensor holder body part 20a. The sensor 18 has the protruding part 20b as hereinbefore described, which protruding part 20b protrudes towards a bearing outer peripheral side beyond the respective  
20                   perimeters of the sensor fitting openings 29 and 30. This protruding part 20b is sandwiched between the bottom surface part 25a of the recessed plate section 25 and opposite plate part 26.

                  In the side plate part 22b of the sensor mounting member 22, a ring-shaped elastic element 31 is sandwiched between the inner plate 23 and the  
25                   outer plate 24 and this elastic element 31 intervenes between an entire inner surface of the recessed plate section 25 of the sensor mounting member 22 and the sensor 18. The elastic element 31 is in the form of, for example, a sheet-like rubber material. The elastic element 31 has a lip part 31a protruding from an inner peripheral edge of the side plate part 22b of the sensor mounting member

22, which lip part 31a has a free end slidably engaged with an outer diametric surface of the constant velocity joint outer race 15. This lip part 31a defines a seal for sealing between the inner member 4 and the sensor mounting member 22.

5           According to the bearing device with the sensor of the structure described above, since the sensor is fitted in a fashion sandwiched between the bottom surface part 25a of the recessed plate section 25 and the opposite plate part 26 provided in the sensor mounting member 22, there is no possibility of the sensor 18 being detached. Because of this, the fitting is assured and high in  
10   reliability. Also, since in this embodiment, the recessed plate section 25 is rendered to have a U-sectioned configuration with the sensor holder body 20a of the sensor 18 arranged in a fashion mounted inside it, an effect of positioning of the sensor 18 relative to the sensor mounting member 22 can also be obtained. Since the sensor mounting member 22 is mounted on the outer diametric surface  
15   of the outer member 3 through the mounting tube part 22a and is axially positioned in contact with the end face of the outer member 3 through the side plate part 22b, the positioning can be easily and accurately accomplished and, therefore, the precision of positioning of the sensor 18 relative to the encoder 17 can be rendered excellent. Also, since the sensor 18 is manufactured separate  
20   from the sensor mounting member 22 and is fitted to the sensor mounting member 22, it is possible to select the sensor mounting member 22 of a size suitable to the size of the bearing part 1 where it is to be fitted to one of the wheel support bearing assemblies of varying sizes. For this reason, for a given sensor 18 made up of the sensor element 19 and the sensor holder 20, the element of the  
25   same size can be used for the bearing part of the varying sizes and, accordingly, the sensor unit 32 including the sensor 18 and the sensor mounting member 22 can be manufactured at a low cost.

Since the sensor mounting member 22 is made up of the inner and outer plates 23 and 24 that are overlapped one inside the other, a work of

sandwiching the sensor 18 between the U-shaped recessed plate section 25 and opposite plate part 26 of the sensor mounting member 22 can easily be performed.

Since the sensor mounting member 22 has the sensor fitting openings  
5 29 and 30 for allowing the sensor 18 to pass therethrough from outside to inside, the sensor 18 can be confronted directly with the encoder 17. Also, since the recessed plate section 25 is provided with the sensor fitting opening 30, drawing of the cord 21 to the outside can easily be accomplished. Also, since the sensor fitting openings 29 and 30 are provided, when the sensor 18 is so arranged that  
10 the outer periphery of the sensor 18 fits to those sensor fitting openings 29 and 30, the positioning of the sensor 18 in respective directions radially and circumferentially of the bearing part 1 is possible and this positioning can further be facilitated.

Since the elastic element 31 intervenes between the bottom plate part  
15 25a of the recessed plate section 25 of the sensor mounting member 22 and the sensor 18, the sensor 18 can be stably retained by the sensor mounting member 22 without being loosened and, also, without an excessive sandwiching force induced. It is to be noted that the elastic element 31 may be intervened between the sensor 18 and the opposite plate part 26.

Also, since the elastic element 31 is such that the lip part 31a is  
20 slidably engaged with the outer peripheral surface of the constant velocity joint outer race 15a, a space between the inner member 4 and the sensor mounting member 22 can be sealed. For this reason, there is no possibility of foreign matters bitten between the encoder 17 and the sensor 18 and biting of sand  
25 particles, which results from scattering of stones from the road surface, in between the encoder 17 and the sensor 18 can be prevented, thereby avoiding damages to the sensor 18 and others. Also, since the sensor 18 and a portion of the encoder 17 confronting the sensor 18 are covered by the sensor mounting

member 22 and the lip part 31a of the elastic element 31, the encoder 17 and the detecting surface of the sensor 18 can be protected from salty mud water.

Since the elastic element 31 concurrently serves as a stable fitting and a sealing means, the sealability can be increased with no need to increase the  
5 number of component parts.

Figs. 3 and 4 illustrates another preferred embodiment of the present invention. This embodiment is such that in the first embodiment described with reference to Figs. 1 and 2, the inner race 12 mounted on the hub axle 11 is fixed to the hub axle 11 by means of a crimped portion 11b formed by curling a rear  
10 end of the hub axle 11. The lip part 31a of the elastic element 31 provided in the sensor mounting member 22 is so arranged as to slidably engage the crimped portion 11b of the hub axle 11 in the inner member 4. It is to be noted that the lip part 31a may have its free end slidably engageable with an end face of the inner member 4.

15 In the case of this construction, the contact of the lip part 31a of the elastic element 31 does not depend on the connecting condition of the constant velocity joint and fitting of the wheel support bearing assembly to the automotive vehicle body can be facilitated. Other structural features and effects of this embodiment are similar to those afforded by the first embodiment.

20 It is to be noted that although any of the foregoing embodiments has been described as applied to the wheel support bearing assembly, the present invention can be applied to any radial rolling bearing in general of a type having the revolution sensor.

Also, although in any one of the foregoing embodiments, the encoder  
25 17 and the sensor part 18 have been described as a magnetic type, they may be an optical type.